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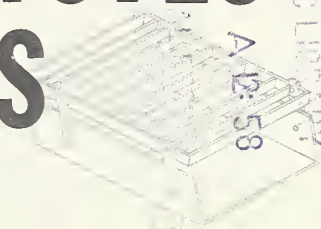
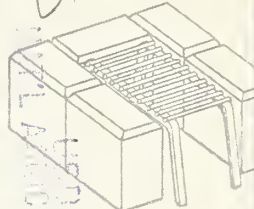
EVALUATION OF CAMPGROUND STOVES AND GRILLS

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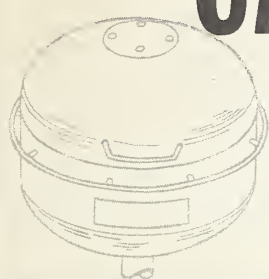
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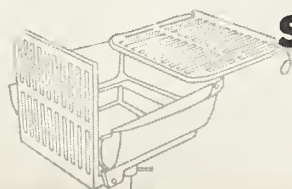
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U.S. DEPARTMENT of AGRICULTURE
FOREST SERVICE
EQUIPMENT DEVELOPMENT CENTER
SAN DIMAS, CALIFORNIA



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Equipment Development and Test Report 2300-2

EVALUATION OF CAMPGROUND
STOVES AND GRILLS

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ABSTRACT

Forest administrators have long been aware of a need for a variety of types of stoves to fit the conditions which prevail in the National Forest camping and picnic areas. To determine which stoves best meet the user's needs while retaining essential requirements, sample units of each type used throughout the Forest Service were evaluated, along with standard commercial types.

After having been tested for structural soundness under controlled conditions at the Forest Service Equipment Development Center at San Dimas, California, 20 units were installed in camp- and day-use sites on the Inyo National Forest to determine the cost of installation, user preference, and maintenance requirements.

On the basis of this first screening, six units were selected for further evaluation. Modification of several of these units was made by the manufacturers to overcome known deficiencies. These units were then retested at the Center.

The stoves which were finally selected have a wide range of physical and aesthetic characteristics which offer a choice of a unit which may best fit individual requirements.

The recommended units* are:

1. Char-Wood, Cat. No. FC-1193 (Code B) 18"x24" and 12"x20"
2. Tilt-Back, Model FT-3 (Code F)
3. Brillion Fire-Ring Grate (Code N) with or without the fire ring
4. Hancock Parkmaster (Code J)
5. Cub Pit (Code O)
6. Firesafe Barbecue (Code T) (For group campground use only)

*All units are pictured in Table 2.

ACKNOWLEDGMENTS

The Equipment Development Center, San Dimas, is most grateful for the cooperation received from the manufacturers whose products were evaluated. Their contributions of equipment and engineering ideas and other helpful suggestions have materially aided this evaluation. There is also a debt to individuals not directly involved in the project who gave of their time and thought to help in the evaluation of the many units.

The interest shown throughout the Forest Service, especially by personnel on the Inyo National Forest, and by other agencies has been high. Their comments and suggestions have been most useful and informative.

In particular, we are especially thankful for the contributions of C.F. Bucklew, Recreation Specialist in the California Region. His help in establishing the field test portions of the project and his ideas in the development of this report were invaluable.

INTRODUCTION

Increased recreation use on the National Forests is resulting in the construction of many new campgrounds and picnic areas. This increased construction has brought new attention to the need for facilities that are practical, economical, and easy to maintain.

Parking spurs have been constructed to accommodate trailers, and varying combinations of wood and concrete tables have been designed to fit the many conditions found on the National Forests. Flush toilets have been installed in many campgrounds. Yet the outdoor stove design has not kept pace with these improvements and changing patterns of use.

Travel trailers and pickup campers now comprise as much as 80 percent of the total number of vehicles in many campgrounds, in sharp contrast to the scene of 20 years ago. In those days, the majority of visitors brought tents and used the outdoor stoves provided in the campgrounds. Since most trailers and pickup campers are equipped with propane stoves (even tent campers increasingly rely on portable gas stoves), the use of outdoor stoves for cooking has noticeably declined.

The many types of petroleum gas and propane stoves now being used are dramatic evidence that many forest visitors prefer the clean heat of gas for cooking chores to the outdoor stove that burns wood or charcoal. However, there is still considerable use of wood stoves or fireplaces to provide recreational or warming fires; and there is little likelihood that a substitute for a wood fire will be found in the foreseeable future, so long as firewood can be found or supplied.

The Campground Stove Evaluation Project is a result of recognized weaknesses in the suitability and cost of stoves for use in present-day recreation sites. Many of these stoves were built according to Forest Service Standard Plates 14A, 14B, and 14E. (See foldout, Codes P, U, and R; also Appendix B.) The problem of suitability of the standard design Forest Service stoves is related to the changes in recreation visitors' habits in recent years and the changing technology which produces better materials and better methods of fabrication. The cost problem is related primarily to rising labor costs, particularly those for custom installation and field maintenance.

The Plate 14A stove, while it is a good basic cookstove, has several shortcomings, which are becoming more serious with each passing year:

1. It has relatively high unit installation costs because of its weight and the necessity of leveling six components to make a completed stove.
2. The stove does not display an aesthetically pleasing recreation fire because of its permanent grate and the small opening on one end.
3. The stove has a very low profile, which makes it uncomfortable to use for cooking.

The Plate 14B stove has been used with success for years in areas of high fire hazard. Since open fires are usually not permitted in sites where the Plate 14B stove is installed, its complete lack of provision for a recreation fire is of little consequence. It does provide an excellent, evenly heated cooking surface. However, it has very high installation costs because of the masonry involved; and it has a reputation for serious maintenance difficulties, which were further borne out in limited testing.

The Plate 14E stove is a general purpose unit intended to provide a good recreation fire as well as a cooking surface. It is an inexpensive stove but can be expected to have a very short life because of its light, and sometimes poor, construction. This stove is an attempt to meet some of the shortcomings of the 14A stove. Its concept is good, but its design needs improvement.

Even without the benefit of exact statistics, it is evident that a cookstove is not needed in National Forest campgrounds today to the same degree as it was just a few years ago. A number of surveys have shown that the proportionate number of travel trailers and pickup campers in campgrounds is somewhere between 40 and 80 percent, depending upon the area of the country surveyed. These vehicles are all equipped with gas cookstoves. Observation of campers using tents or soft-top travel trailers shows that a large percentage use portable gas cookstoves. Nothing has been proposed as a substitute for the recreation fire as a relaxing gathering place for talk or marshmallow roasts or as a background for other camping activity. The recreation fire is more popular than ever, as evidenced by the fires built on top of conventional cookstoves and the proliferation of camper-constructed fire rings in camping units. A need exists for a good recreation-fire fireplace that will also convert to a usable cookstove for the occasional camper who uses a wood fire for cooking.

Grilling of meat over charcoal in a barbecue caught on as a popular family activity a number of years ago. It has spread to National Forest recreation sites. Some of its popularity is undoubtedly due to the shortage of on-site free firewood and the convenience of packaged charcoal. It is not particularly convenient to rely on charcoal for the preparation of entire meals; therefore, the charcoal barbecue seems to be much more popular with day-users than with campers, although many campers give barbecuing an occasional trial. No Forest Service standard stove is suitable for charcoal use, yet there is a definite need for this type of facility, particularly in day-use sites. A stove capable of efficiently utilizing charcoal or wood would be particularly useful in many situations.

OBJECTIVE

The objective of this project was to evaluate the stoves available on the market to find inexpensive, sturdy units which will fill one or more of the three major areas of need, as follows:

1. Satisfy campers' needs for an aesthetically pleasing recreation fire which is also usable for cooking.
2. Allow the use of charcoal for barbecuing of meat.
3. Lower the costs of installation and maintenance for a completely closed, firesafe stove.

TEST PROCEDURE

On the basis of a Service-wide survey, seven types of representative Forest Service and 14 types of commercial stoves and grills were selected and purchased for evaluation. These are illustrated in the foldout. Six each of most types were tested. Obvious duplications in units were avoided, and the study was limited to units which had a variety of features.

1. Initial tests were conducted at the Equipment Development Center. The stoves were installed much as they normally would be in a campground. Test fires of both dry pine firewood and charcoal were first burned in one of each type of unit to establish standard heating patterns. After a 30-minute warmup period, temperatures were recorded at set points on the stoves and blocks, using a contact pyrometer. After the standard heating patterns were established, LP gas burners were constructed to reproduce these conditions in each stove of the same type. Before each stove was fired for the actual test, an 18-pound weight was dropped on it from a height of 2 feet to simulate a rock or pot of water being dropped; and the degree of deformation was recorded. The stoves were then fired for 30 minutes, and any deformation or component failure from the heat was recorded. Again the weight was dropped on the stove to determine deformation. Finally, 2-1/2 gallons of water were thrown into the firebox to simulate dousing the fire. A final examination was made for deformation or failed components and the results recorded.
2. Additional data compiled for each unit are:
 - a. Manufacturer
 - b. Model or identification
 - c. Cost per unit
 - d. Shape and dimensions of firebox
 - e. Type of fuel suitable
 - f. Presence of ash receptacle
 - g. Total weight
 - h. Type of metal and coating
 - i. Cooking, grilling, or warming fire capabilities
 - j. Firesafe features, such as cover and doors
 - k. Fire-to-grill adjustment

- l. Drainage features
 - m. Wind guard and adjustment capabilities
 - n. Work space
 - o. Height of unit
 - p. Grill rotation independent of firebox
 - q. Type of mounting or stand
 - r. Grill area
 - s. Ease of cleaning and ash removal
 - t. Utensil storage
 - u. Vandalproof features
 - v. Degree of deformation of steel due to heat or cold and its effect on operation and service life
 - w. Failure of components and welds
 - x. Hazards in operation, hot spots, handle temperatures, or provisions required to eliminate safety hazards
 - y. Other observations
3. After the tests at the Development Center were completed, samples of the units were installed in campgrounds or picnic grounds in the Mammoth Lakes area of the Inyo National Forest.
 - a. Records were kept of the cost of labor and materials for the installation of the units. Cost of materials will vary slightly between Regions. However, these records should serve as a reliable comparison of installation costs.
 - b. Periodic observations were made to determine the degree of failure of components. These checks were made every weekend throughout the summer of 1965.
 - c. Each weekend, people using the stoves and grills were questioned regarding their opinion of the units.
 4. A conference was held at San Dimas to compare the test data, evaluate the visitors' comments, and study the installation and maintenance costs as compiled after the tests and one season's field use. On the basis of this analysis, six of the stoves were selected as being most adaptable for proposed use in Forest Service recreation sites.
 5. From the results of the first tests it was determined that certain improvements or changes in the six models would make them more acceptable for use. Contacts were then made with the manufacturers to obtain modified units.

6. When the modified units were received at the Development Center they were again tested for structural soundness and utility.
7. The modified units were then sent to the Inyo National Forest for field test.

RESULTS OF INITIAL TESTS

A summary of these initial tests showing hardware and installation costs, temperatures, user comments, and other pertinent information is given in Table I. More detailed information regarding each unit is listed below.

Code A - Pedestal Model GD-3

This unit can be used with charcoal or small sticks of wood. The grill height is adjustable to four positions. The shallow (4-3/4 inch) firebox does not provide an adequate wind guard. Water must drain out the front of the firebox. The unit will rotate 360° on the stand, to which it is permanently attached.

Both wood and charcoal fires were burned in one of the test units. The charcoal did not burn well. Most of the heat produced was carried off by the wind because of the grill construction. With the wood fire, the grill handles were too hot to touch.

The grill appears to have excessive internal stress which caused it to warp, buckle, and twist during the heating and quenching operations. Also, the grill was twisted on its center mount during the weight-drop test. One grill bar broke loose during the heating and quenching operation.

The firebox swivel and grill adjustment tended to rust and stick and, on several units, had to be forced. There is no ash retainer on the unit or drain hole for water.

Code B - Charwood, Cat. #FC-1193

Either wood or charcoal can be used as a fuel with the four-position adjustable grill. A lip on the front of the firebox acts as an ash retainer, and drainage has been provided for water. The firebox can be rotated on the stand to provide a wind guard. The grill fastens to the stand by a hidden rod - cotter-pin arrangement. The unit does not provide a work space or storage for utensils.

Both wood and charcoal test fires were burned in one of the units. No deformation was noted during the weight-drop test. However, some minor deformation occurred during the heating and quenching test. This caused the grill to rock slightly in its adjustment slots.

Where the units were heated, the firebox reached a temperature of 560°F.; and the handles of the grill became too hot to hold without gloves.

Generally, this grill appeared to be the best for cooking and barbecuing, but it would not provide a satisfactory warming fire.

TABLE I
INITIAL EVALUATION SUMMARY

Code	Hardware Cost	Installation Cost	Fuel	Damage in Tests & Field	Test Temp.		Grill Eff.	Fire Hazard Rating	Grill Size (Inches)	Weight (Pounds)	Visitor Comments
					W	C					
A	\$23.50	\$ 3.50	C-W	Heavy	560	220	3	16-3/8 x18	60		Handles too hot Does not pivot easily Grills well
B	26.20	3.50	C-W	Slight	610	460	2	11-1/2 x12	71		Should be slightly larger Grills well Good adjustment of grill
C	28.65	3.50	C-W	Slight	500	500	3	10 x21-1/2	76		Too small Does not take large pieces of wood Grills well
D	27.15	3.50	C-W	Slight	500	500	3	10-3/4 x22	76		Too small Does not take large pieces of wood Grills well
E	28.50	3.50	C-W	None	525	440	2	14 x15	100		Grills well Does not take large pieces of wood Burns very well (underfire draft)
F	16.50	12.00	C-W	Moderate	600	—	2	8 x20-3/4	70*		Good cooking surface Does not grill well Good for warming fire
G	31.70	4.50	C-W	Moderate	660	380	2	13-1/2 x19-1/4	96		Grills well Grill hazardous to change
H	49.00	3.50	C-W	Moderate	—	380	2	24 dio.	69		Does not turn Grills well. Shelves adequate Difficult to keep wood fire going
I	39.00	3.50	C-W	Moderate	—	380	2	16 dio.	46		Does not turn Grills well Shelves adequate
J	50.35	10.00	C-W	Moderate	820	—	1	6-1/4 x14	153		Excellent outdoor cookstove No way to adjust grill for barbecue Shelves handy
K	46.67	10.00	C-W	None	855	—	1	21-1/2 x15	78		Excellent outdoor cook stove No way to adjust grill for barbecue
L	30.00	3.50	C-W	None	500	500	2	16 x19	139		Grill hard to clean Lowering grill may pinch fingers Grill not good for ground meat
M	22.50 w/bose	20.00	W	None	680	—	2	16 x24	49**		Not tested in field due to previous F.S. experience
N	42.00	3.00	W	None	780	—	3	23 x30-1/2	268		Not tested in field during this phase of project.
O	40.00	3.50	C	Moderate	—	460	2	19-1/4 dio.	62-1/2		Excellent grilling with any meat Does not turn Shelves adequate
P	22.50	20.00	W	Slight	760	—	2	16 x24	59**		Too low for comfortable cooking
Q	25.50	20.00	W	Slight	710	—	2	16 x24	58**		Too low for comfortable cooking Makes good open fire
R	12.00	14.00	W	Slight	600	—	2	23 x24 wedge	28-1/2**		Too low for comfortable cooking Makes good open fire
S	18.50	20.00	W	Heavy	740	—	2	14 x27-3/8	27**		Too low for comfortable cooking
T	95.00	3.50	C-W	Moderate	380	—	1	22 dio.	96		Not tested in field
U	21.06	37.00	W	Moderate	780	—	1	16 x25	85***		Not tested in field because of previous F.S. experience

*Without Concrete Base

**Without Concrete Blocks

***Without Concrete Firebox

TABLE I (continued)

The following descriptions of each category in the data summary identify the coding and rating systems:

CODE

A letter is assigned to each unit and used throughout all the testing records. For visual comparison, check the same letter on fold-out sheet.

UNIT COST (HARDWARE)

This is the cost to the Government of the metal unit. It does not include material necessary for installation but does include the pedestal and mounting if such are integral parts of the unit.

INSTALLATION COST

Includes labor, equipment, and materials.

FUEL

Type of fuel the unit will use:

- W = Wood
- C = Charcoal
- C-W = Charcoal and/or Wood

DAMAGE BY USE

There was not much damage to the units during testing or use. The following breakdown will provide an opportunity to rate each unit:

- None — No damage of any kind, nor noticeable warping.
- Slight — 1. Units show some warping during heat and quench tests and in field use but return to normal position.
 - 2. Minor bending of components.
 - 3. Breaking of minor welds.
- Moderate — Units show minor warping during tests and field use and retain the deformation (less than 1/4").
- Heavy — Units show breaking of welds and bending and warping of components that do not return to normal position after cooling. Key support welds breaking or bending in excess of 1/4".

FIRE-HAZARD RATING

1. Has good retention of fire and coals within the unit. Has controlled draft that will put out the fire when closed, or can be closed on all four sides.
2. Has good retention of fire and coals within the unit. Is subject to wind on one end.
3. Does not hold coals well, or is subject to the wind on two or more sides.

Code C - Miracle Grill, Model P

This unit is constructed of a cast iron firebox and grill with a steel ashpit. The grill is cast in two pieces, which swing back for adding fuel. Slots in the front of the firebox provide a draft. Holes in the back corners of the ashpit allow water drainage. The unit is secured to the stand by a hidden spring-loaded pin arrangement, which allows the firebox to be rotated. Either charcoal or small pieces of wood can be used for fuel.

Both wood and charcoal were burned in one of the test units. Although this unit is primarily intended for charcoal, it was found that wood burned more slowly and gave a slightly better heating pattern. No damage resulted from the heating and quenching or weight-drop tests. The grill handles became too hot to touch. With the draft slots on the front of the firebox and no retainer on the ashpit, coals fall out onto the ground.

The grills on these units were warped upon receipt to the point that they rocked on the firebox.

Code D - Everwear Stove, Model W-600

These stoves were almost identical in features and construction to the Miracle Grill described under Code C. The only apparent difference is the method of hinging the grills.

The test results were the same as those for the Miracle Grill, except that in assembly three of the units would not go onto the stand far enough for the pin in the stand to latch into the slot on the unit.

On one of the six units, one grill had to be forced in order to rotate it because the hinge pin was too short.

Code E - Park Outdoor Grill

The cast iron construction of this unit provides even heat distribution over the grill. Charcoal or small pieces of wood can be used for fuel, although the grill height is not adjustable. Both grill and grate are hinged to simplify both adding fuel and cleaning. The firebox can be rotated on the stand to provide a wind guard. The unit fastens to the stand by a semihidden bolt. Water must drain out the front of the ashpit. Neither work space nor utensil storage is provided.

Both wood and charcoal fires were burned in one of the test units. Because the grate provides a draft, the charcoal was consumed quite rapidly. Wood burned more slowly; but, because of the size of the unit, only small sticks can be used. However, the cast iron grill construction distributes and holds the heat quite evenly.

The swing-over grill and grate make the unit very easy to fuel and clean. The unit can be rotated on its stand, but it does not always rotate freely.

Code F - Tilt-Back Fireplace, Model F-T-1

This unit can be used to provide either a cooking or a warming fire when wood is used as fuel. The legs, which are pinned to the firebox, allow the unit to be pivoted over backwards. The legs, which form an ell, are cast 4 inches into a concrete base. The hotplate extends past the left side of the grill, and food can be kept warm there. The concrete base provides both work and storage space near ground level.

Only wood was burned during the tests, although the unit could possibly be used for charcoal grilling.

The handle on the front reached a dangerous temperature of over 400°F. with the wood fire. The unit was difficult to raise after it had been warped by the heat. It returned to its original shape when it was quenched with water. On one stove, a grill strip broke loose from the hotplate when the unit was warped.

Very little deformation occurred when the weight was dropped on the cold unit. However, the grill was bent slightly and the overhanging plate bent considerably when the weight was dropped on the hot unit.

Three different concrete mixes were used for the bases; however, none were heat-resistant concrete. The wood fires caused cracking in all of the bases. Since the tests were intended to evaluate the grills, the units were not penalized for the cracked bases.

Code G - Pedestal Park, Type B

This unit has a two-position grill which makes it suitable for both cooking and grilling, using either wood or charcoal. To adjust grill height, it must be drawn out and replaced at the desired level. A chain is attached to the grill and firebox to prevent theft. The deep firebox provides an adequate wind guard. The grill can be rotated on the double-pipe stand, to which it is attached by a large stud and nut. A lip on the front of the firebox retains ashes, while small holes in the back provide water drainage.

Both wood and charcoal were burned in the test units.

All but one unit had warped grills prior to the test. This was probably due to the welded rod construction. The warping caused the grill to rock on its supports. Additional warping up to 1/8 inch occurred during heating and quenching. Some buckling of the firebox side was also noted.

The units attach to the two-pipe stand by a large nut. They could be stolen by simply removing this nut. The units were difficult to rotate freely on the stand.

The grill adjustment is somewhat of a safety hazard in that the entire grill must be drawn out the front of the unit and then reset at the new position. The handles became too hot to touch with bare hands, and the grill could be easily dropped. It is connected to the firebox by a heavy chain in such a way that, if dropped, it could endanger the user.

This unit appears to be a good camping grill as far as actual cooking is concerned. However, there are problems with safety and warpage that could be solved only by major design changes.

Codes H & I - Clover Leaf Park

These units were the de luxe versions of the available models. The only difference between these and the standard models was the addition of shelves on each side to provide working and storage space. Although they are intended primarily for barbecuing with charcoal, wood can be used in the larger model. The rectangular grills are hinged at the back, with a four-position adjustment at the front. Holes in the bowl allow water to drain out. Brackets are provided to lock the unit to the stand; however, this prevents rotating the firebox.

Although wood could be burned in these units, the test fire was charcoal. No deformation was noted from heating and quenching. During weight-drop tests, slight bending of the grill occurred when it was cold; up to 3/8 inch when hot.

There is no wind guard on the units, and they cannot be swiveled.

Codes J & K - Parkmaster

The Code J unit is equipped with shelves and the Code K is not. Otherwise, they are identical. The stoves are heavily constructed, suitable for burning wood or charcoal. The grill is cast in two pieces, each of which slides out to a stop. A grate holds the fuel above the ashpit. Dampers on each side of the ashpit allow full regulation of draft and provide a straight-through passage for removing ashes. The stove swivels on the stand, to which it is connected by a concealed fastener. Two shelves on the Code J model provide work and storage space.

Only wood was burned to determine the standard heating pattern. The entire surface of the units, except the draft doors and shelves, became hot. No deformation was found from heating or quenching. However, a shelf was bent considerably during the weight-drop test. The intense heat of the stove scorched the paint. This unit operates much like the old wood cookstove. It is heavy and rugged except for the shelves.

Since the unit is intended to be bolted to a concrete base, it could easily be removed.

The dampers were hard to open and close. A handle on them would help. Also, several of the units were difficult to rotate on their stands.

Code L - Pedestal-Type Grill - USDA - Forest Service, Rocky Mountain Region

This unit permits both cooking and grilling, with a choice of wood or charcoal as fuel. The grill is attached to the firebox by four arms, which keep it level as it is raised. It has two positions, one being 2 inches higher than the other. The shallow (4-1/2 inches deep) firebox does not provide an adequate wind guard. A lip on the front of the firebox acts as an ash retainer, and small holes at the back allow water to drain out. The unit can be rotated on the stand, to which it is permanently

attached. There is no provision for work space or utensil storage.

Both wood and charcoal were burned to determine the standard heating pattern. In most cases the temperature of the firebox sides exceeded the maximum grill temperature. This was probably due to the wind pattern at the time of the test and the vertical metal strip configuration of the grill. The handle temperature reached a maximum of 140°F., which generally is too hot for comfort.

No deformation or damage, other than paint scorching, was noted during the tests.

Code M - Cast Iron Grill

This grill is intended for optional use with the USDA - Forest Service Standard Plate 14A Fireplace (Code P). It is constructed of cast iron rather than steel bars. The unit permits only wood as a fuel because of the distance from fire to grill. The concrete blocks form a wind guard and provide limited storage and work space.

No deformation or damage to the grill was noted during the tests.

Code N - Brillion Fire Ring

The primary use of this unit is as an enclosure for a warming fire. The firebox - 32 inches in diameter x 10 inches deep - provides ample volume for a large fire. A pivoting cast iron grill gives a means of cooking if the camper so desires. The heavy construction and the method of installation make the unit relatively safe from vandalism and theft.

The grill can be rotated back to leave the ring clear for a warming fire. It does form somewhat of a safety hazard when in this position.

No damage or deformation was noted during the tests.

Code O - Cub Pit

This unit is primarily a charcoal barbecue grill, although small pieces of wood could be used as fuel. The grill is made of expanded metal and is adjustable to six positions. A wind guard is provided, but the unit will not swivel on its stand. Four holes in the fire bowl allow water drainage. The unit is relatively theftproof because of its integral body-and-stand construction.

Only charcoal was used during the tests to establish the standard heating pattern. No grill warpage was noted during heating, but quenching with water caused about 3/8-inch deformation. When cold, the expanded metal bent during the weight-drop test, and the entire grill was bent 3/4 inch when hot. The weight was dropped on one shelf, bending the outer edge down 3/4 inch.

One of the water drain holes is directly over the height-adjustment handle. Hot coals could fall from this hole onto a camper's hand while he is adjusting the grill. This hazard could be corrected by relocating the holes.

Code P - Fireplace - USDA - Forest Service Standard Plate 14A

This unit provides a cooking fire using wood as a fuel. The fireplace is enclosed on three sides by five concrete blocks. The blocks and the grill framework extend 8-1/2 inches below and 9-1/2 inches above ground level. The blocks afford limited work and storage space. The grill is constructed of 3/4-inch square steel bars welded to an angle iron framework.

A slight amount of deformation was noted on the grill from heating and water quenching.

Three different concrete mixes were used for the test blocks. The first mix used only sand as aggregate. The second used aggregate up to 1/4-inch maximum size. The third used variable aggregate up to 3/4-inch size plus an air-entraining admixture. Compressive strengths of the three mixes were:

Mix 1 - 3659 psi

Mix 2 - 5477 psi

Mix 3 - 6881 psi

No cracks formed in the blocks, nor was any surface flaking encountered during the tests. Temperatures at the outside of the blocks were near ambient, while the inside surfaces were close to the temperature of the fire.

Code Q - Fireplace - Rocky Mountain Region Modification of FS Standard Plate 14A (Code P)

This grill is similar to that described in Code P, the difference being that the front half is hinged so that it may be lifted to add fuel and enhance its use as a recreation fire. Also, the angle iron legs were somewhat shortened. Otherwise the grill and angle iron framework is identical to that of Code P.

The shortened legs made the unit more difficult to anchor in the ground without pouring a concrete base.

Two types of hinging - one a pin, the other a rivet - were used on the test grills. Both worked equally well.

Some of the 3/4-inch square grill bars warped slightly from the heating and quenching. There was only about 1/16-inch deformation from the weight-drop test when the grill was hot.

Code R - Flip-top Fireplace - USDA - Forest Service Standard Plate 14E

The grill hinges at the top left side to a two-sided concrete block firebox. The two blocks are joined at the corner by one of the grill's hinge pins. The unit can be used as either a cooking or warming fire, with wood as a fuel. The top of the blocks allows for very little work and storage space, as one edge is beveled.

No damage to the grill from heating and quenching was noted in any of the tests, other than a slight warping on one of the six units.

The blocks used were obtained from the Pacific Northwest Region. They were made of lightweight aggregate. One of the blocks broke at the corner joint during assembly. This was due to the lack of reinforcing mesh in that particular area. All blocks developed vertical cracks during the tests.

Code S - Fireplace - California Region Modification of USDA - Forest Service Standard Plate 14A

The design of this grill is quite similar to that of the Code P grill. However, the grill bars are 1/2 inch square; and the angle iron frame is lighter. Also, the legs angle away from the grill. This makes it more difficult to place the concrete blocks around the unit, but it does leave a larger opening at the front for adding fuel.

Some minor deformations resulted from heating and quenching. During the weight-drop test the grill bars bent 1/16 inch when cold and 3/16 inch when hot.

Because of the angled legs the unit is more awkward to handle and set up. It is also more susceptible to damage during installation and use.

Code T - Firesafe Barbecue

This unit has several advantages over the other barbecue grills tested. The cover allows it to be used as an oven, and it will extinguish the fire when the vents are closed. The combined use of the damper on the firebox and the vent on the cover provides a means of regulating the temperature of the grill. Utensils can be hung on the ring which encircles the unit. The fire bowl is large enough to permit the use of wood as well as charcoal. The unit does not provide for the drainage of water. Brackets enable the unit to be locked to the stand. The grill is hinged so that it can be lifted when fuel is added. Because of the relatively high cost, only one unit was obtained for test. Charcoal only was used as a test fuel.

During the burning test the entire outside became too hot to touch. On one side, the utensil ring reached a temperature of 180°F.

No damage resulted from heating and quenching. However, the grill, when hot, bent considerably during the weight-drop test.

The unit will not swivel, but the cover provides a sufficient wind guard. The cover also closes tightly enough to smother the fire, and there is little chance of any sparks or coals getting out.

Code U - USDA - Forest Service Standard Plate 14B (Klamath)

This unit, used primarily in the California Region, is considered to be a firesafe, as well as a convenient, outdoor stove. It consists of a concrete firebox with a

cast iron top plate secured by bolts imbedded in the concrete. The door frame is also secured to the firebox in the same manner. The smokestack is fastened to a flange on the top plate. It is intended that a masonry, brick, or rock structure be built around the firebox to enhance its aesthetic value and provide some work and storage space.

Only wood was used as a fuel in the one unit tested. The cast iron plate provided good heat distribution. However, the plate cracked across its center during the weight-drop test.

The concrete firebox cracked in several places when the fire was extinguished with water. Subsequent heating and cooling widened these cracks and started additional fine cracks.

EVALUATION, SELECTION, AND MODIFICATION

The results of the initial tests were analyzed by Development Center engineers and staff and field recreation specialists. Factors considered were: Design features, usability, versatility, hardware and installation costs, maintenance problems, user reaction, and susceptibility to damage and vandalism. On the basis of this study six units which appeared to have the most desirable characteristics for a variety of uses were selected. Those chosen were:

Char-Wood Cat #FC-1193 (Code B)
Tilt-Back Fireplace Model FT-1 (Code F)
Parkmaster (Code J)
Brillion Fire Ring (Code N)
Cub-Pit (Code O)
Firesafe Barbecue (Code T)

Although these units were felt to be the best suited for Forest Service use, it was evident from the tests that improvements or modifications could be made to each one to eliminate certain deficiencies. Therefore a list of recommended changes was developed. The recommendations for each unit were as follows:

Code B - Char-Wood Cat. #FC-1193

1. Increase height of ash lip to 2".
2. Enlarge unit to 24" x 18".
3. Enlarge plate section of grill to 18" body by 10" wide.

Code F - Tilt-Back Fireplace Model FT-1

1. Redesign grill portion to eliminate distortions and weld breaks and to make grilling and cleaning easier.
2. Increase slack on the two pivot points.

Code J - Parkmaster

1. Design solid top with short draft vent.
2. Design shelf to eliminate bending.
3. Change method of installation to avoid bolting to cement block.

Code N - Brillion Fire Ring

1. Adaptation of the idea to a swing-over grate mounted on a pipe support that will work on any fire ring.

Code O - Cub-Pit

1. Design unit to turn.
2. Strengthen shelves.
3. Relocate drain hole in base to eliminate hot ashes falling onto adjustment handle.
4. Strengthen expanded metal grill supports.

Code T - Firesafe Barbecue

Develop identical unit, but only half the size, for areas that have a fire hazard.

This information was presented to the respective manufacturers for the purpose of securing modified units. All of the manufacturers were very cooperative, and modified stoves were obtained from all except one. The manufacturers of the Firesafe Barbecue felt that their costs necessary to build a smaller unit precluded submitting a modified unit at this time.

The modified units were tested for structural soundness and utility, as in the initial tests. The objective was to determine if the modifications were satisfactory and if performance was improved. In all but one or two minor instances the units performed as expected. In view of the repetitious nature of the tests and the lack of any major problems, details of the results are omitted.

Code F Tilt-Back was redesignated as Model FT-3, Code N renamed as Brillion Fire-Ring Grill, Code O changed to Cub-Pit (Forest Service Model), and Code J changed to Hancock Parkmaster (Solid Plate Model).

RECOMMENDATIONS

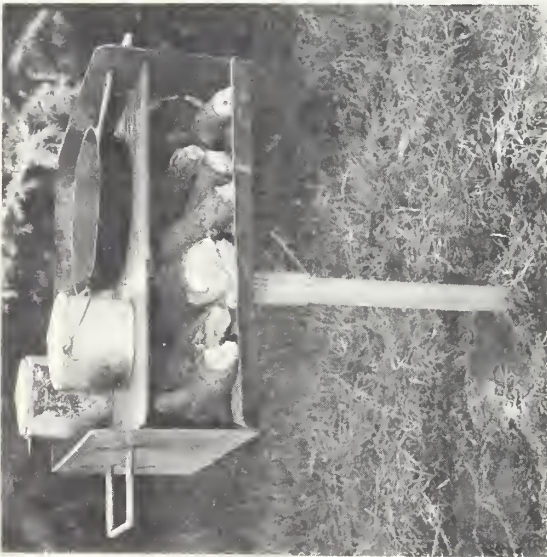
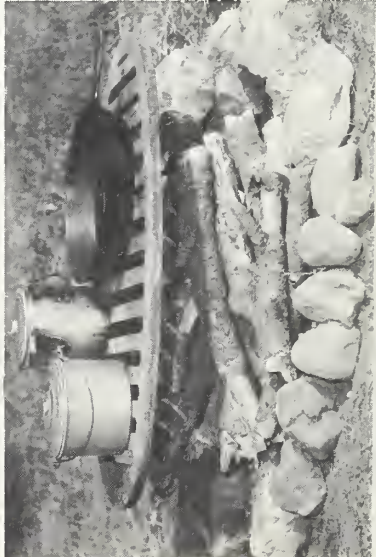
Many new kinds of campground stoves and grills have become commercially available in the past few years. This project has been an attempt to evaluate some of these that appeared to have the greatest adaptability to Forest Service use. There are no published standards for performance. Selected units have not been in the field long enough to establish service life conclusions. Individual location requirements almost negate the possibility of recommending one or two units as being applicable to all conditions. In spite of these factors, it was felt that there were many advantages to be gained from submitting the several units for standardization.

On the basis of the evaluation presented herein, it is recommended that:

1. The units illustrated and described in Table 2 be considered for Forest Service standards.
2. a. The Brillion Fire-Ring Grill and the Tilt-Back FT-3 be used in preference to the current Forest Service stoves described by Standards 14A and 14E. A refractory concrete is still needed for options proposed for these units. Some information has been assembled and is presented in Appendix A.

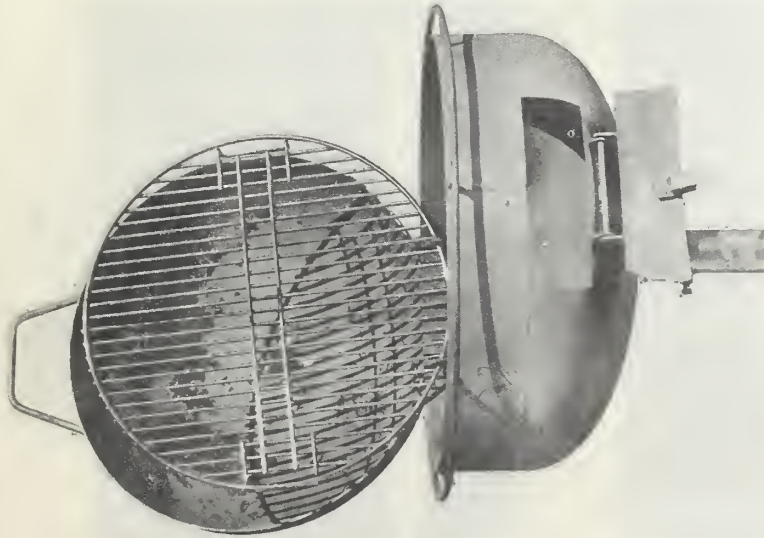
- b. The Hancock Parkmaster (Solid Plate Model) be considered as a fire-safe fireplace in preference to the Klamath, Forest Service Standard 14-B.
 - c. The Cub Pit (Forest Service Model) and Char-Wood (available in two sizes) be used for barbecue units.
 - d. The Firesafe Barbecue still be considered for group day-use sites in high-fire-hazard areas.
- 3. The market be monitored for other units which have desirable features.
 - 4. Development work be initiated to design a better fireplace for a recreation fire which can be converted for use as a cookstove, since a commercial stove completely satisfactory for this use was not found.

TABLE II - DESCRIPTION OF RECOMMENDED UNITS

Reason for Selection	Name & Address of Manufacturer	Cost*		
		Hardware	Installation	Total
 1. Simplicity of design 2. Good grill temperature 3. Lack of any weld breakage 4. Unit swivels 360° on stand 5. Low cost 6. Low installation cost 7. Grill adjustment	Belson Mfg. Co. North Aurora, Illinois 60542	\$27.50	24" x 18" size \$3.50	\$30.75
		\$19.88	20" x 12" size \$3.50	\$23.38
 1. Quick and easy to install. 2. All-purpose stove - cooking or recreation 3. Grill could be used with ring or any other type of fireplace.	Brillion Iron Works Brillion, Wisconsin 54110	\$22.45	\$4.50 /1	\$26.95

∠1 Cost for installation of grill only. Cost of cement or rock fire ring would be additional.

*Note: 1965 prices, single units, f.o.b. mfr.



Firesafe Barbecue (Code T)



Tilt-Back Model FT-3 (Code F)

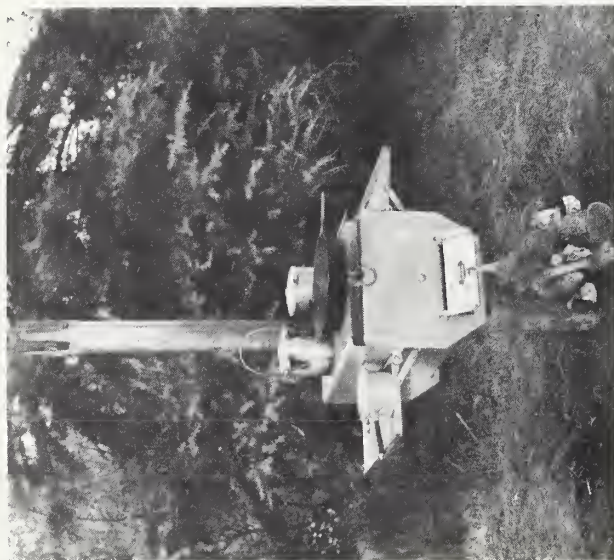
Reason for Selection	Name & Address of Manufacturer	Cost*		
		Hardware	Installation	Total
<ol style="list-style-type: none"> 1. Cover allows use as oven. 2. Grill temp. can be regulated by adjustment of damper and vent. 3. Cover provides windguard, as well as making unit firesafe. 4. Closing of vents and damper extinguishes fire. 5. Size is good for group camp-grounds. 	<p>Rasmussen Iron Works 1007 W. Philadelphia Whittier, Calif. 90601</p>	\$95.00	\$3.50	\$98.50
<ol style="list-style-type: none"> 1. Best meets needs for an all-purpose campground stove. 2. Good area for cooking. 3. Grilling may be done on plate or bars. 4. Tilts back for recreation fire. 	<p>Central Texas Iron Works Waco, Texas 78203</p>	\$23.50	\$12.00	\$35.50

*Note: 1965 prices, single units, f.o.b. mfr.

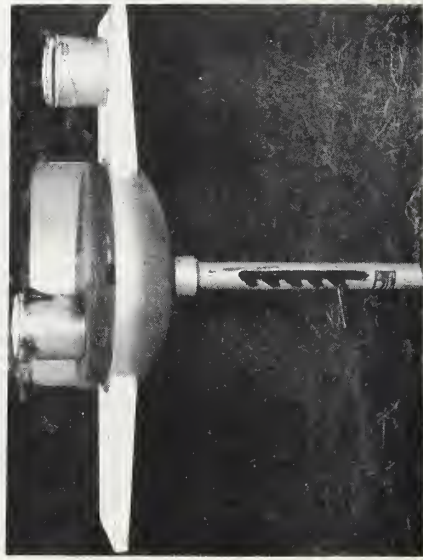
TABLE II (cont.)

Reason for Selection	Name & Address of Manufacturer	Cost *		
		Hardware	Installation	Total
1. Excellent heating characteristics 2. Controlled draft features 3. Easy ash removal 4. Enclosed fire-box	Hancock Iron Works Pontiac, Michigan 48056	\$46.50	with shelves \$4.50	\$51.00
1. Best features for barbecuing 2. Good grill height adjustment 3. Expanded metal grill excellent for holding meat	H.A. Wood Co., Inc. Box 752 Paso Robles, Calif. 93446	\$48.00	\$3.50	\$51.50

*Note: 1965 prices, single units, f.o.b. mfr.



Hancock Parkmaster
(Solid Plate Model) (Code J)



Cub Pit (Code O)
(Forest Service Model)

APPENDIX A

REFRACTORY CONCRETE

Problem:

The Forest Service has had the problem of deterioration of concrete when it is used as a liner or enclosure material for grills and stoves. Mortar used with concrete blocks has also cracked and broken away, adding to this problem. The cause is sustained heating and subsequent quenching with cold water. The trouble recurs not only in the Klamath stove (plate 14B) but also in the Standard 14A model and its various modifications. It is believed that the use of high alumina cement and light-weight aggregate plus correct methods of mixing, placing and curing could overcome many of the problems.

Solution:

The most positive solution is using high alumina cement and lightweight aggregates and proper methods of mixing, placing, and curing the concrete. The materials and methods are discussed below. This information was developed through consultation with the Materials Investigation Section of the California Region, as well as in discussions with Portland Cement Association representatives.

Materials and Mixes:

Of the commercially available cements, one will be referred to in particular as a basis, with different aggregates in various mixes. Lumnite, a high alumina cement, can be obtained with relative ease and used with Firebrick, Rocklite, Ridgelite, and Haydite - all of which are commercial lightweight aggregates. Lumnite cement, according to the manufacturer's literature, can sustain temperatures up to 2000°F. and withstands hot-cold treatment well. Lumnite patches easily and cures quickly, which are good maintenance factors. See next page for suggested mixes.

The aggregate should be a 1/4 inch, minus lightweight and porous material. Rocks or gravel are not to be used because they can explode when heated. Do not use sand in the mix, as it deteriorates at temperatures over 500°F.

The use of an air-entraining agent not only improves the workability of the fresh concrete but also helps the concrete's resistance to freezing and thawing exposure in the cured state. The amount of air-entraining agent used varies from 5 to 8 percent by volume. When an air-entraining agent is used, less water is required - usually a gallon less per sack of cement. The water used in the concrete is to be clear and free from organic and other deleterious materials.

It takes 3 gallons of water per sack of cement for complete hydration of the cement. The remaining water in a mix is for convenience only (in working with the concrete and wetting the aggregate). Five to six gallons of water per sack of cement will give a good, 4,500 psi to 5,500 psi concrete (28 days' cure). Assume a 3- to 4-

MATERIALS	MIX BY VOLUME	COLD COMPRESSIVE STRENGTH* (psi, min)	APPROXIMATE MATERIAL QUANTITIES TO PRODUCE ONE CUBIC FOOT CONCRETE					
			By weight			By volume		
			Cem. lbs.	Water lbs.	Aggr. lbs.	Cem. bags	Water gal.**	Aggr. cu.ft.
Lumnite -	1:3	1500 @ 12 hrs. 5000 @ 28 days	31.3	16.6	92.3	.33	2	1
Crushed Firebrick	1:4	1250 @ 12 hrs. 5000 @ 28 days	24.5	12.5	92.3	.26	1.6	1
Lumnite -	1:3	1250 @ 12 hrs. 5000 @ 28 days	31.3	16.6	66.8	.33	2	1
Haydite	1:4	1000 @ 12 hrs. 4000 @ 28 days	24.5	12.5	66.8	.26	1.6	1

*The compressive strength should be not less than 1,800 psi in 7 days and 3,000 psi in 28 days.

**One gallon water weighs 8.3 pounds.

inch slump; a 3-inch slump is a good standard. If an air-entrained agent is used, as previously stated, approximately one less gallon of water per sack of cement is needed.

When a smaller aggregate is used, more cement paste is required. Before being mixed, the materials should be kept as cool as possible - especially Lumnite, which needs a cool and dry atmosphere.

If there is less water, there is less shrinkage. It takes about 1 year for 90 percent of the extra mix water to come out of the concrete. This determines shrinkage. Excessive moisture in concrete is one of the primary causes of spalling. Another important factor contributing to this defect is overworking or excessive vibration (rodding).

If many successive batches of machine-mixed concrete are to be mixed on the job, it is advisable to wash out the mixer drum after every three or four batches and discard the wash water. Keep mixing tools and water containers clean. Prolonged mixing should be avoided. Concrete should be mixed and placed into the form as quickly as possible.

Placing:

Forms should be reasonably watertight and inside surfaces oiled or treated to stop the absorption of mixing water from the concrete by dry wood. Use more small control joints rather than a few larger joints.

Wire mesh is used as a temperature reinforcement and should be located in the middle of the slab, block or ring. Structural reinforcing bar is not to be used for concrete subject to high temperatures. The thermal expansion rate of steel is greater than that of concrete, which increases the probability of cracking.

Curing:

Keep the mixing water in the concrete for at least 3 days. The best method for doing this is through water-curing, either flooding or spray-mist, flooding being the preference. Plastic sheet may be used for flat surfaces where the plastic is in direct contact with all cement surfaces, but it is not recommended for irregular shapes. Other methods use sand, burlap, canvas, or straw; but these are not as good because they must be kept moist. Alternate wetting and drying is worse than no treatment. Moist-cured concrete (for 7 days) will have double the strength of improperly cured concrete.

Do not let new concrete freeze. The longer concrete has been cured before exposure to fire, the less chance there will be of failure.

Mortar:

Preparation of refractory mortar is very similar to that of the concrete. Lumnite cement mixed with an aggregate of crushed firebrick or expanded shale in a 1:3 (by volume) or 1:4 mix is sufficient. Too much water reduces the strength of the mortar.

Workability of mortar will be improved by addition of finely ground plastic fireclay, which also requires slightly more water. This further reduces the temperature sensitivity of the mix. Water and the equipment used to store and handle water should be clean.

APPENDIX A - BIBLIOGRAPHY

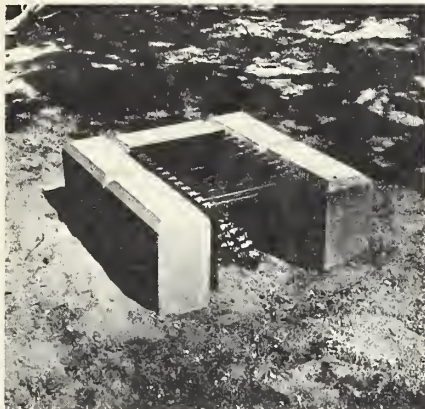
PORTLAND CEMENT ASSOCIATION PUBLICATIONS

- ST 100 — Design of Concrete Mixtures
- ST 32-3 — Effect of Long Exposure of Concrete to High Temperature
- ST 89 — Air-Entrained Concrete
- ST 101 — Fundamental Facts about Concrete
- ST 95 — Curing of Concrete
- ST 90 — Mixing Water for Concrete
- ST 102 — Admixtures for Concrete
- ST 91 — Aggregates for Concrete
- ST 106 — Suggested Specifications for Plain and Reinforced Concrete
- ST 82 — Structural Lightweight Concrete
- ST 99 — Volume Changes of Concrete
- ST 93 — Hot Weather Concreting
- ST 94-2 — Cold Weather Concreting
- T 140 — Fire-Resistance of Reinforced Concrete Floors by John P. Thompson

UNIVERSAL ATLAS CEMENT, DIVISION OF U.S. STEEL PUBLICATIONS

- ADVAC 505-59(7-EM-WP) — Atlas Lumnite Cement — Mortar Manual
- ADVAC 510-65(7-10M) — Refractory Concrete Manual

APPENDIX B - CONSTRUCTION INFORMATION

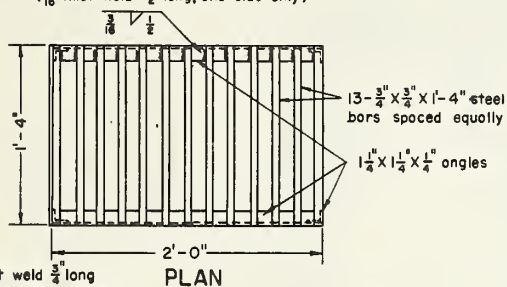


FACSIMILE

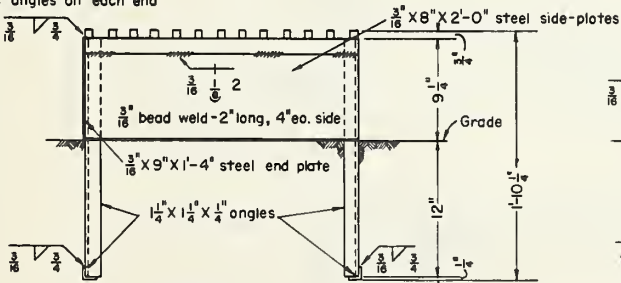
Options

1. Use 3 concrete blocks instead of 5.
2. Use native rock on sides and end. Select rock to withstand heat. Sides facing fire box and top faces shall be flat.
3. Grill with open ends and block sides. If two blocks are used to each side, shorten each block to 14 in.
4. Grill only. No stone, conc. block, steel side or end plates.
5. For community picnic areas, grills may be placed end to end and racks or conc. blocks shall be placed on the sides.
6. Steel side and end plates may be $\frac{1}{4}$ in. thick. Do not set conc. blocks or rocks in mortar. Do not use building blocks. Use poured conc. blocks made with the mix shown under specifications.

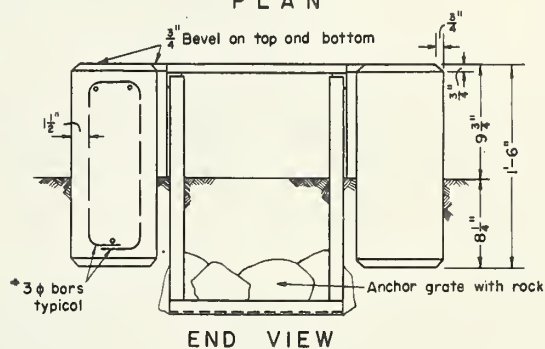
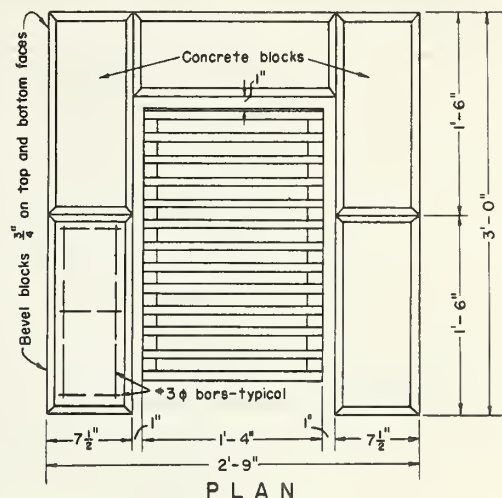
($\frac{3}{16}$ " fillet weld $\frac{1}{2}$ " long, one side only)



$\frac{3}{16}$ " fillet weld $\frac{3}{4}$ " long at angles on each end



0 3" 6" 9" 1' 2'
Scale



SPECIFICATIONS

Portland Cement, Air Entraining-AASHO M134-57, Type IA or IIA
Light Weight Aggregates: A.S.T.M. C-330-57T

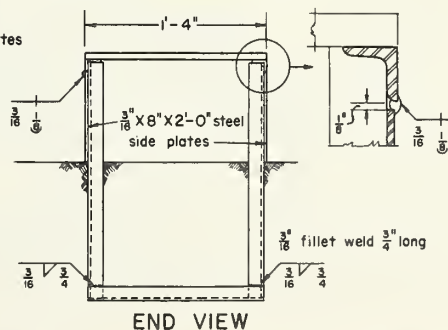
Mix for Concrete Blocks: 1 part cement, 3 parts sand or light weight aggregate maximum size $\frac{1}{2}$ inch, water, least amount to make a workable mix.

Reinforcing Steel-A.S.T.M. A-305-53T (for concrete blocks)

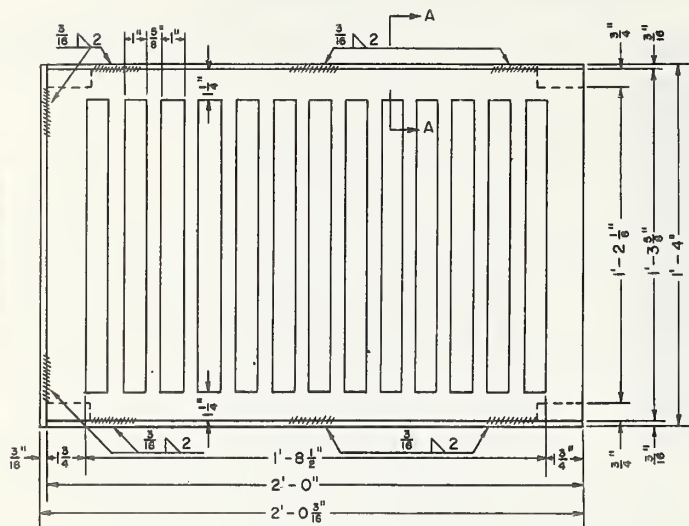
Structural Steel-A.I.S.I. M-1020 (for steel grate)

Steel Plate - A.S. ... A-7 - 56T

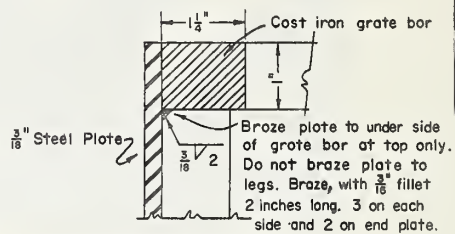
Welding to be done in a workmanlike manner.



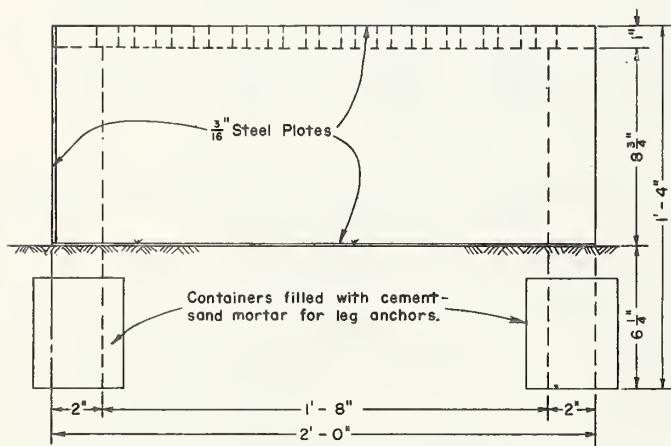
Weight of grill with side end plates = 87 lbs.



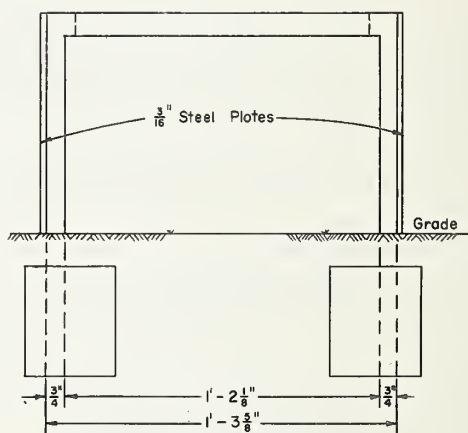
PLAN



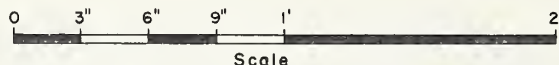
BRAZING DETAIL SEC. A-A



SIDE ELEVATION



END ELEVATION



Note:

The grate shall be gray cast iron cast in one piece. The top shall have 13 openings 1'-1" long and 1" wide separated by 12 bars $\frac{5}{8}$ " wide and 1" thick.

Each grate shall have 2 steel plates $\frac{3}{16}$ " x $9\frac{3}{4}$ " x 2'-0" and one plate $\frac{3}{16}$ " x $9\frac{3}{4}$ " x 1'-4" brazed to the grate at the top only.

Each leg shall be anchored in a container filled with cement-sand mortar. Be sure anchors do not extend to where they will interfere with the installation of the concrete block or stone sides and end shown on plate 14 A.

Option: Steel plates may be omitted.

Weight of cast iron grate 77 pounds

Weight of steel plates 34 "

Total 111 pounds

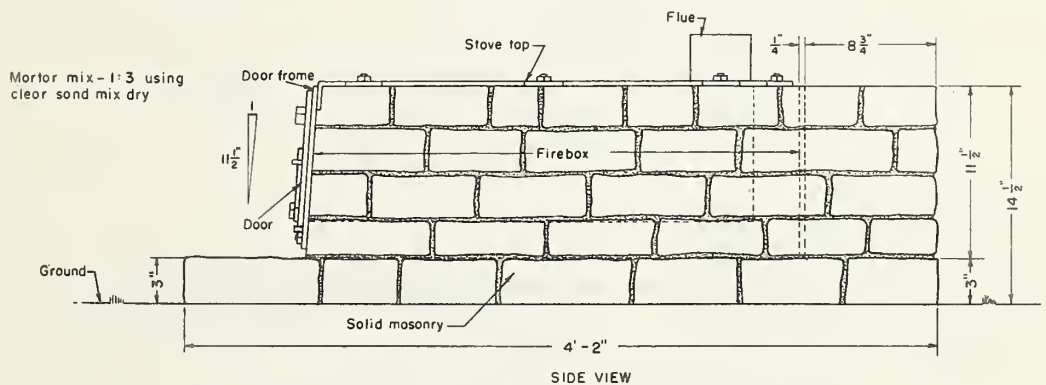
Note: This grate can be substituted for the welded steel grate shown on Plate 14 A.

Specification:

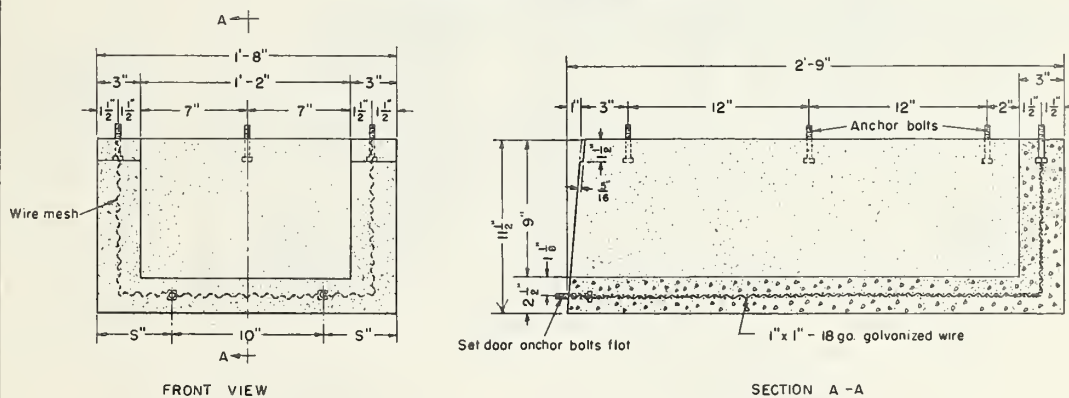
Iron Castings, Gray Fed. Spec. QQ-I-652A

Steel Plate, A.S.T.M. A-7-56T

Structural Steel, A.I.S.I. M-1020



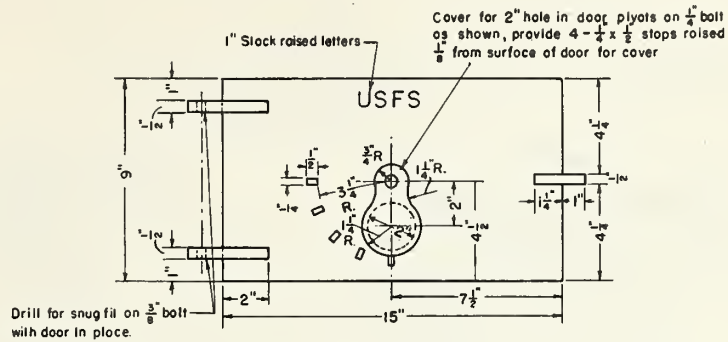
Use asbestos cement to seal space between cast iron door frame and concrete firebox.
On assembly do not bolt top and front tightly to firebox, leave room for expansion. Peen ends of bolts to prevent nuts being unscrewed.



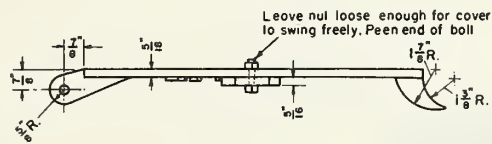
Concrete for firebox should be 1:2:2.5 mix using clean sand and aggregate. Reinforce with wire mesh as shown.
Anchor bolts, $\frac{3}{8} \times 5"$, 9 required.

[illegible]

Material - Cast Iron
Hinge pin made of $\frac{3}{8}$ " x $8\frac{1}{2}$ " bolt,peen
end of bolt after assembly so that
door cannot be removed.



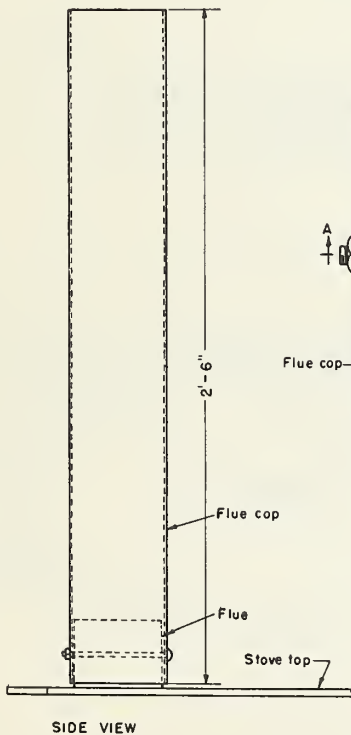
FRONT VIEW



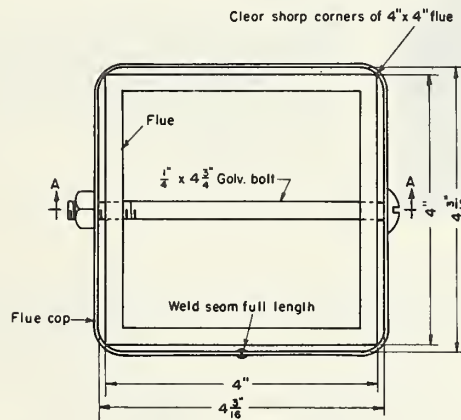
TOP VIEW

DETAIL OF DOOR

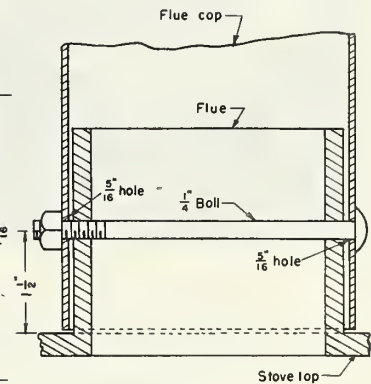
Material - Cast iron
 $\frac{1}{4}$ x $\frac{1}{2}$ bolt - 1 required



SIDE VIEW



TOP VIEW

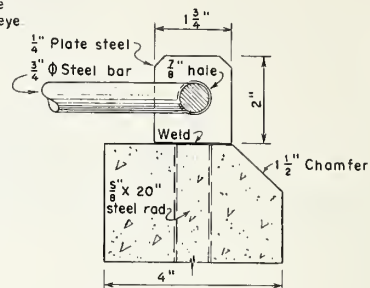


SECTION A - A

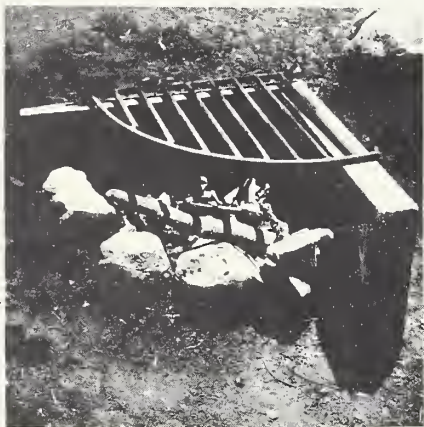
DETAIL OF FLUE CAP

Material $\frac{1}{16}$ " sheet iron
 $\frac{1}{4}$ x 4 $\frac{3}{4}$ bolt - 1 required

Elevate eyebolt 2" & slightly twist clockwise to let grill end enter eye



Scale 6' = 1'-0"



One cu. ft. 3" to 4" slump - 70 lbs. aggregate - $1\frac{3}{4}$ gal. water - 20 $\frac{3}{4}$ lbs. cement - $\frac{3}{8}$ oz. air-entraining agent (measure carefully). If slump is above 3" add $\frac{1}{4}$ gal. water. If slump is below 4" cut water to $1\frac{1}{2}$ gal. and add 2 lbs. aggregate. Mix air-entraining agent with water in the mixer. Add cement when this is well-mixed. Add aggregate slowly. Use vibrator.

* High early cement

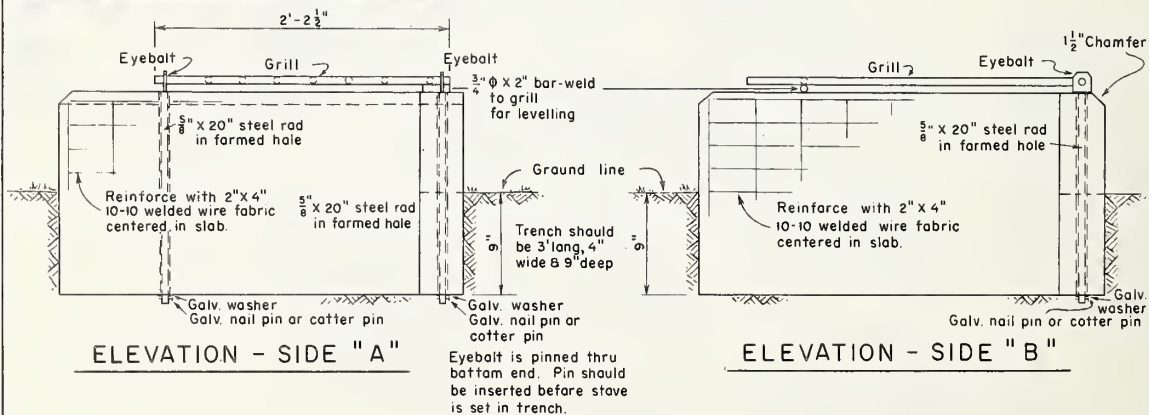
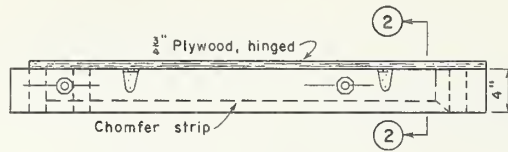
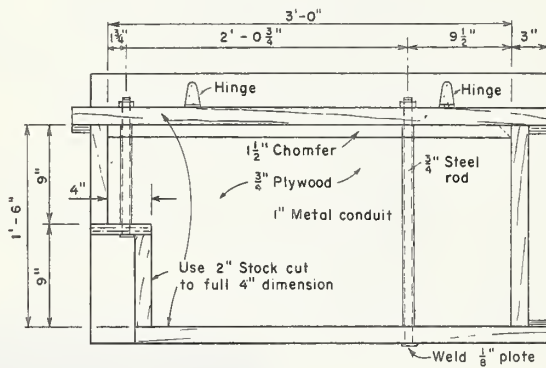


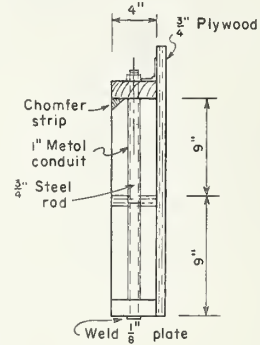
PLATE 14 E
SHEET 1 OF 2
NOVEMBER 1963



FORM PLAN - SIDE "A"

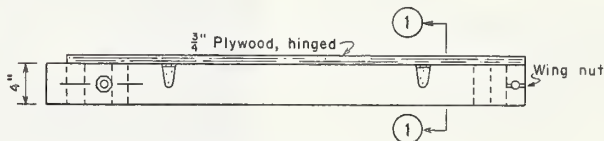


FORM ELEVATION - SIDE "A"

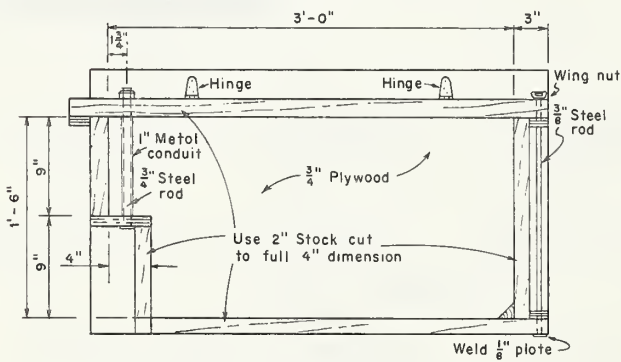


SECTION 2-2

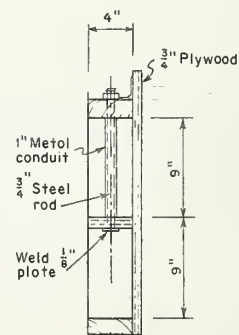
Note:
Oil inside of forms
for easier removal
of concrete.



FORM PLAN - SIDE "B"

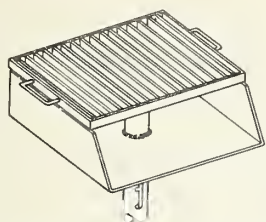


FORM ELEVATION - SIDE "B"

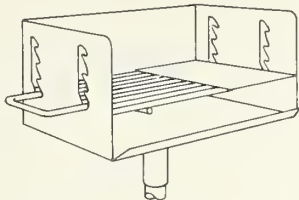


SECTION 1-1

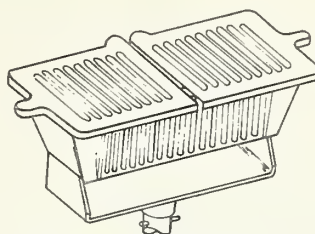
STOVE AND GRILL CODE IDENTIFICATION



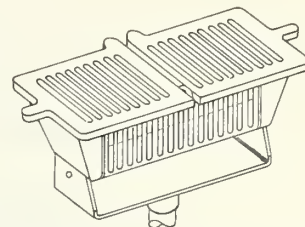
CODE A Pedestal Model GP-3
Central Texas Iron Works



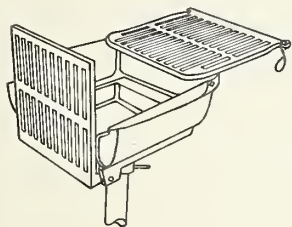
CODE B Char-Wood
Cat. #FC-1193 Belson Mfg. Co.



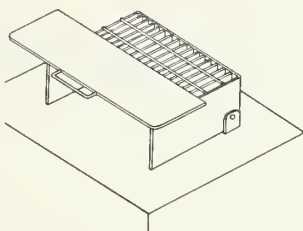
CODE C Miracle Grill
Model P Stacy Equip. Co.



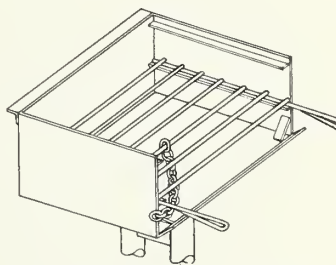
CODE D Everwear W-600
Safeway Steel Products, Inc.



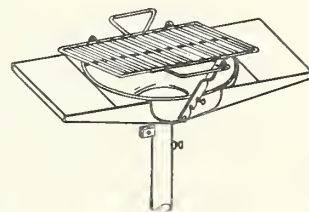
CODE E Park Outdoor Grill
Model ID240 Brillion Iron Works



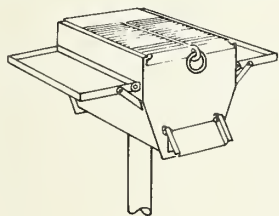
CODE F Tilt-Back Model FT-1
Central Texas Iron Works



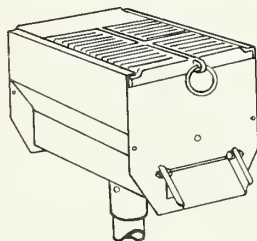
CODE G Pedestal Park Type B
Kay Enterprises



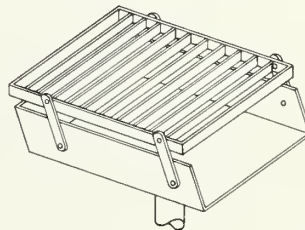
CODES H & I Clover Leaf Park
Rasmussen Iron Works



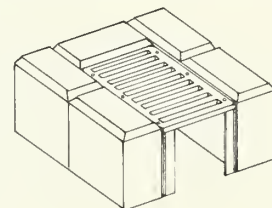
CODE J Hancock Parkmaster
Hancock Iron Works



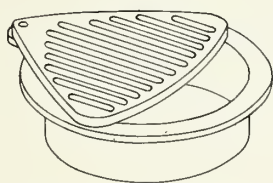
CODE K Hancock Parkmaster
Hancock Iron Works w/a shelves



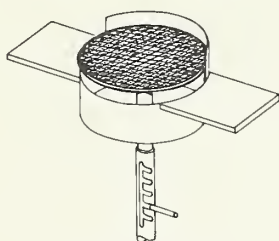
CODE L R-2 F.S. Std. Pedestal



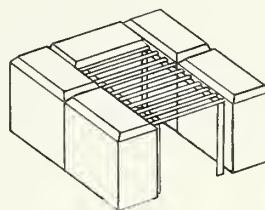
CODE M R-9 Mod. F.S. 14A
(Brillion Grate IG-334)



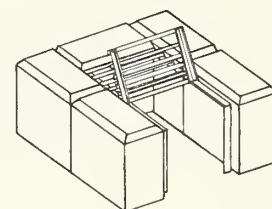
CODE N Brillion Fire Ring
and Grate Brillion Iron Works



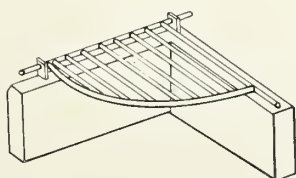
CODE O Cub Pit
H.A. Wood Co., Inc.



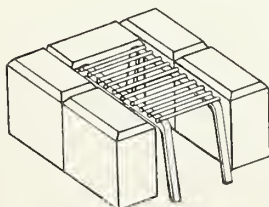
CODE P F.S. Std. Plate 14A



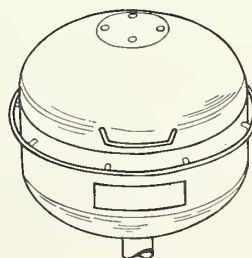
CODE Q R-2 Mod. F.S. 14A



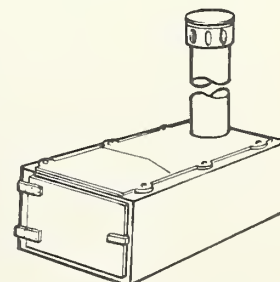
CODE R Flip-Top
Forest Service Plate 14E



CODE S R-5 Mod. F.S. 14A



CODE T Firesafe Barbecue
Rasmussen Iron Works



CODE U (Klamath) F.S. Std.
Plate 14B

ADDRESSES OF MANUFACTURERS

Belson Manufacturing Company
North Aurora, Illinois 60542

Brillion Iron Works
Brillion, Wisconsin 54110

Central Texas Iron Works
Waco, Texas

Hancock Iron Works
Pontiac, Michigan 48056

H.A. Wood Co., Inc.
Box 752
Paso Robles, California 93446

Rasmussen Iron Works
1007 W. Philadelphia St.
Whittier, California 90601



